SEASONAL FLIGHT ACTIVITY OF BUMBLEBEES (HYMENOPTERA: APINAE) AS MONITORED BY MALAISE TRAP CATCHES

Michael E. Archer

Department of Biology, College of Ripon & York St. John, York YO3 7EX.

Watts (1983) positioned a series of Malaise traps in Bernwood Forest in the English Midlands to study the hoverflies (Diptera, Syrphidae). Aculeate Hymenoptera were also trapped and after being sorted by Watts were sent to me for mounting and identification. This paper is primarily a descriptive report of the bumblebees trapped, with details of the relative abundance of each species. Similar reports of the social wasps and solitary species have been reported (Archer, 1988, 1990). Information about habitat conditions for Bernwood Forest are given by Watts (1983).

Seasonal abundance data of some British bumblebees has only recently become available. Sladen (1912), Free & Butler (1959) and Alford (1975) reported the length of seasonal activity of many species but did not report on seasonal abundance. Prŷs-Jones & Corbet (1987) reported the seasonal abundance of four species: *Bombus terrestris* (L.), *B. pratorum* (L.), *B. hortorum* (L.) and *B. pascuorum* (Scop.). Outside Britain Løken (1973) gave flight data for each caste and sex of Scandinavian species and Moorse (1982) and Plowright & Laverty (1984) reviewed world data. Information on foreign bumblebees, which was also considered by Alford (1975), dealt with dates of seasonal activity rather than seasonal abundance.

Methods

Five Townes Malaise traps (Townes, 1972) were operated at Bernwood Forest from 1 April to 30 September during 1980, 1981 and 1982 and were sampled at weekly intervals providing 26 samples per year.

Orientation and siting in a habitat can greatly affect a Malaise trap catch (Disney *et al.*, 1982) so the position and orientation of each trap was the same each year. The efficiency of a Malaise trap in sampling bumblebees is unknown but traps are probably selective not only in the species trapped but also in the sex and caste of individual bees taken. However for common species the Malaise trap would seem to be very effective in reflecting the amount of activity of aerial insects (Owen, 1983).

Results and analysis

Five species, *B. lucorum* (L.), *B. terrestris*, *B. pratorum*, *B. hortorum* and *B. pascuorum*, were captured in sufficient numbers for further analysis. A further four species, *B. ruderarius* (Müller), *Psithyrus barbutellus* (Kirby), *P. sylvestris* Lepeletier, *P. vestalis* (Geoffrey in Fourcroy), were captured as single specimens or in small numbers.

The numbers of each sex/caste of the five species trapped are given in Table 1. The most recorded species, *B. lucorum*, was more than five times as abundant as the least recorded species, *B. terrestris*. The most frequently recorded sex/caste was workers except for *B. pratorum* and *B. hortorum* where males were most frequently recorded.

The seasonal level of activity of each sex and caste of the five species is given in Fig. 1. Rather less data were available for *B. pratorum*, *B. terrestris* and *B. hortorum*

Table 1. The number and percentages of each sex/caste of bumblebees trapped at Bernwood Forest between 1 April and 30 September from 1980 until 1982.

Species	Queens	%	Workers	%	Males	%	Total
B. pratorum	34	23.9	38	26.8	70	49.3	142
B. terrestris	38	32.2	49	41.5	31	26.3	118
B. lucorum	109	16.7	418	63.9	127	19.4	654
B. hortorum	32	13.6	91	38.6	113	47.9	236
B. pascuorum	112	20.4	367	66.8	70	12.8	549

so that for these species the weekly data have been combined into biweekly readings so that the patterns of seasonal activity are more clearly discernable. The queens were already active when the trapping started during April and were recorded throughout, or for most of, the trapping period. During June numbers of queens

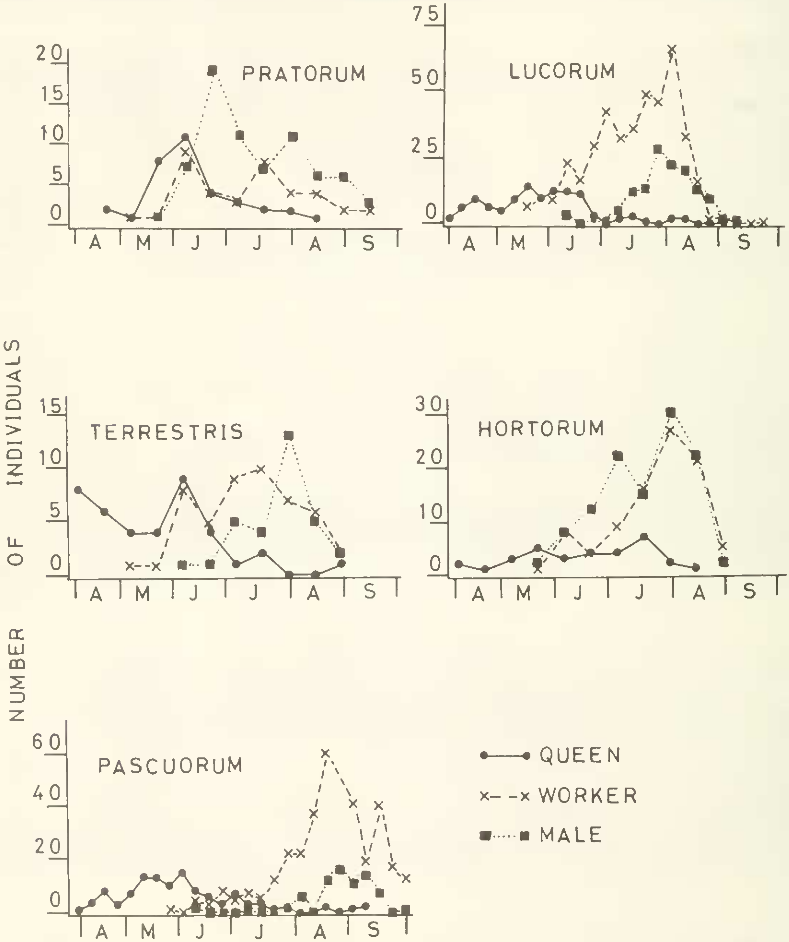

Fig. 1. The adult flight activity of *Bombus* species at Bernwood Forest from 1980–1982.

dropped to a lower level at which they remained for the rest of the season except for *B. hortorum*. Queens of *B. hortorum* were only taken in small numbers and because of this small sample size probably no trend is discernible.

Workers of all the species were recorded first in May but the timing of the highest worker activity varied between the species. Workers of *B. pratorum* showed the earliest peak of activity during early June although this species also showed a second peak during mid-July. The extended peaks for *B. terrestris* and *B. lucorum* came next lasting from June until July or even early August. The peak for *B. hortorum* was later from mid-July until mid-August while the peak for *B. pascuorum* was later still from mid-August until mid-September.

Males of all species, except *B. pratorum*, first appeared during June; those of *B. pratorum* during late May. The peaks of male activity varied between species with *B. pratorum* having the earliest peak during late June and a second peak during early August. The males of *B. hortorum* also showed two peaks of activity, during early July and early August. The peaks of *B. terrestris* and *B. lucorum* were next from late July until early August. The peak of *B. pascuorum* was last from late August into September.

Although all the species were taken throughout most of the trapping period the period of maximum activity was shorter for *B. hortorum* and *B. pascuorum* as these species took longer to reach the exponential growth stage of activity and *B. hortorum* stopped rather abruptly at the end of August. *B. pratorum* reached the exponential growth stage of activity first but then activity did not come to an end because a second cycle of activity occurred.

Discussion

The inter-specific differences relating to the sequence of maximum activity recorded agree with Alford (1975) and Prŷs-Jones & Corbet (1987). *B. lucorum*, *B. terrestris* and *B. pascuorum* are called long-cycle species as their life-cycle of about 6 months is longer than that of the short-cycle species, *B. pratorum* and *B. hortorum*, although these two species with a second peak of activity increase their length of seasonal activity. The second peak of activity of *B. pratorum* and *B. hortorum* is usually considered as evidence of a second generation (Prŷs-Jones & Corbet, 1987). However Duchateau & Velthius (1988) showed for *B. terrestris* that different colonies varied in the date at which the colony switched to male production. The early switching colonies produced males with very few queens while late switching colonies produced more queens than males. Although the population of different switching colonies still showed a single peak of worker activity such a population might show two peaks of male activity. Thus the data for *B. pratorum* probably does indicate the presence of two generations a year as both males and workers showed two peaks of activity. However for *B. hortorum* since only the males showed the two peaks of activity the presence of early and late switching colonies is perhaps more likely than a second generation.

What are the reasons for the variations of activity of each sex/caste during the season? For example why are more queens recorded as being active during the first part compared with the second part of the season? There will be more new queens reared than there are spring queens because of the mortality of over wintering queens. Perhaps an explanation can be found by an examination of queen behaviour. The spring queens engage in foraging for food to aid ovary development, in searching for suitable nest sites and again in foraging for food to secrete wax for nest building and to feed the first brood. Such foraging and searching activities will increase the chances of the queens being trapped. In contrast the new queens at first remain in the nest feeding on stored pollen to aid development of their fat bodies and on honey to fill their crops (Free & Butler, 1959). Then follows a brief period of activity outside the nest for mating before entering the over wintering sites. Queens of *B. pratorum* and *B. terrestris* start entering over wintering sites from July onwards (Alford, 1975). The relative short period of activity by the new queens outside the nest probably reduces the predation risk but will also decrease their chances of being trapped.

Again why should males be the most frequently trapped sex/caste for *B. pratorum* and *B. hortorum* compared with workers for the other species (Table 1)? Males are active outside the nest when patrolling their mating circuits and foraging from flowers since males do not normally return to the nest once having left it (Alford, 1975). Such activities increase the chances of the males being trapped. The occurrence of two periods of male activity for *B. pratorum* and *B. hortorum*, while the other species only have one period, could account for the greater relative frequency of males of these two species in trapped samples.

References

Alford, D.V. 1975. *Bumblebees*. Davis-Poynter, London.

Archer, M.E. 1988. The aculeate wasp and bee assemblage (Hymenoptera: Aculeata) of a woodland: Bernwood Forest in the English Midlands. *Entomologist* **107**: 24–33.

Disney, R.H.L., Erzinolioglu, Y.Z., Henshaw, D.J. de C., House, D., Unwin, D.M., Withers, P. & Woods, A. 1982. Collecting methods and the adequacy of attempted fauna surveys with reference to the Diptera. *Field Studies* **5**: 607–621.

Duchateau, M.T. & Velthius, H.H.W. 1988. Development and reproductive strategies in *Bombus terrestris* colonies. *Behaviour* **107**: 186–207.

Free, J.B. & Butler, C.G. 1959. *Bumblebees*. Collins, London.

Løken, A. 1973. Studies on Scandinavian bumble bees (Hymenoptera, Apidae). *Norsk Ent. Tidsskr.* **20**: 1–218.

Moorse, D.H. 1982. Behaviour and ecology of bumble bees. In Hermann, H.R. (ed.) *Social insects* Vol. 3. pp. 246–322.

Plowright, R.C. & Laverty, T.M. 1984. The ecology and sociobiology of bumble bees. *Annu. Rev. Ent.* **29**: 175–199.

Prŷs-Jones, O.E. & Corbet, S.A. 1987. *Bumblebees*. Cambridge University Press, England.

Owen, D.F. 1983. A hole in a tent or how to explore insect abundance and diversity. In Gupta, V.K. (ed.) *Studies on the Hymenoptera*. American Entomological Institute. pp. 33–47.

Sladen, F.W.L. 1912. *The humble-bee*. Macmillan, London.

Townes, H. 1972. A light-weight Malaise trap. *Ent. News* **83**: 239–247.

Watts, J.O. 1983. A comparative study of the Syrphidae (Diptera) from different habitats within Bernwood Forest. Ph.D. thesis. Oxford Polytechnic.